November 1972 December

AMC Safety Digest

AMCP 385-110

DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY MATERIEL COMMAND
Washington, DC 20315

AMC PAMPHLET
NO. 385-110

NOVEMBER-DECEMBER 1972

The Safety Digest is an AMC Pamphlet prepared by the Safety Office, Headquarters, US Army Materiel Command. Its purpose is to disseminate information which can materially influence and improve safety programs at all command establishments.

Articles are included to supplement technical knowledge as well as practical knowledge gained through experience. They provide a basis for the further refinement of safety measures already incorporated in operating procedures and process layout. To achieve maximum effectiveness, the Safety Digest should be given widespread circulation at each AMC establishment.

Articles appearing in the Safety Digest are unclassified and are not copyrighted. They may be reproduced as desired in order to bring pertinent accident prevention information to the attention of all employees. The AMC Safety Digest should be given a credit line when articles are extracted.

Unclassified material believed to be of interest or benefit to other establishments is welcome for publication in the Safety Digest. Please send articles for review to US Army Materiel Command Field Safety Agency, Charlestown, Indiana. If possible, include pictures, charts, drawings, and illustrations that clarify and heighten interest in your presentation.

(AMCSF)

FOR THE COMMANDER:

OFFICIAL:

James P. Cahill

JAMES P. CAHILL
Colonel, GS
Chief, HQ Admin Mgt Ofc

CHARLES T. HORNER, JR.
Major General, USA
Chief of Staff

Special Distribution

AMCP 385—110
NOVEMBER-DECEMBER 1972

IN THIS ISSUE

IT'S SNOW TIME AGAIN!

Whenever we see a commercial on TV, an advertisement in a magazine or a safety article about winter driving and automotive maintenance, we want to "turn it off." It's old hat -- the same old warnings, the same "do's" and "don't's," the same "nevers" and "always."

But whenever you stop to think about it, there is rarely anything new about common sense in regard to safe practices. It's a simple fact that if a person hears a thing often enough, it will become second nature for him to think about what's safe and what isn't when a given situation arises. Thus, the reason for talking up winter driving safety over and over again. The driver must know what to do and when to do it, and how to prepare for what might happen.

- Everyone knows that ice and snow pose dangerous driving problems. The routine 20-minute drive to work in the morning can easily turn into an hour's hazardous struggle. Drivers' nerves begin to get on edge, as they wonder if they're going to get to work on time and without denting a fender on the new car. Take it easy! Don't try to rush. It's better to be late for work than to leave a widow with four small children.

- Watch the distance between you and the car in front of you. Leave three or four times more space in front of you than you would under ordinary driving conditions.

- What about those tires? Is the tread good? Snow tires are better. Studded tires are better than snow tires. Chains are best of all. The extra feet of stopping distance you save with good tires or chains may mean the difference between an accident and a safe stop.

- Do your windshield wipers work perfectly? Visibility is low enough in a snow storm, let alone having wiper blades that miss and streak. Use those windshield washers -- but not unless you're sure the water won't freeze when it hits your windshield. If necessary, pull off the road -- well off the road -- and wipe the car windows clean.

- How about your car's exhaust system? Don't add the danger of carbon monoxide inside your car to the snow and ice on the outside. Have the exhaust system checked before cold weather sets in. Just a few minutes in a carbon monoxide atmosphere won't give you time to have it checked later.

(Cont on page 18.)

IT'S POSSIBLE FOR THE IMPOSSIBLE TO BE POSSIBLE

Julian L. Vann, Chief Safety Engineer
Harvey Aluminum Sales, Inc.
Milan Army Ammunition Plant

The above photograph shows (left to right) Paul Hardison, Dee C. McPeake and Laymon T. Goldsmith. The story about the three men would be classified as fiction by the layman. Although we don't really know how the insurance actuaries would establish probabilities for such a feat, we are betting these three men have established a notorious collective record in the area of safety. Mr. McPeake, Mr. Hardison and Mr. Goldsmith have worked at the same plant as professional vehicle drivers for a collective total of 90 years. They have driven various types of tractor-trailer rigs in all types of weather and at all times of the day and night. They have endured bumper-to-bumper traffic on plant and state routes which are not adequate to accommodate this load of traffic. "Believe it or not," none of these three drivers has ever been involved in a vehicle accident while on duty. There is no written or memory record that either man has so much as dented a fender.

It would be impossible to accurately calculate the total number of miles driven by these three men, but based on current mileage records, the figure is estimated to exceed a total of 1,000,000 miles.

We realize the safe driving record of these employees can well be termed "a miracle," because fate has provided them immunity from the wrath of the reckless and inattentive drivers. However, each man can be worthily accredited with a personal no-fault driving record.

An award program established two years ago for professional tractor-trailer drivers has provided the incentive for other drivers to follow in the footsteps of Messrs. McPeake, Hardison and Goldsmith. Twenty-seven of the 35 professional drivers now employed at Milan Army Ammunition Plant are wearing gold-plated engraved belt buckles which were awarded for exceeding five years without a vehicle accident.

*****

SAFETY SHOE DOES IT AGAIN

Ralph Dothage (right), an employee of Lake City Army Ammunition Plant, was mowing grass around farm machinery with a rotary-type mower. Although at home, he had followed the Plant's advice and was wearing his safety shoes. He stepped back and fell over a wagon tongue. The first blow of the mower blades hit the top of his shoe. When the blade came around again, it caught the sole of his shoe, ripping a deep gash. The construction of the shoe resulted in Dothage sustaining nothing more than bruised toes. Once more, the value of wearing safety shoes during certain activities both on and off the job can be publicized because of an accident with a happy ending.

KNOWLEDGE VS DESIRE

By Dr. Victor E. Schultze, Jr.

••All pilots are urged to read this article. In capsule form Dr. Schultze has revealed the subsurface motives of the risk taker. In the flying business all too often the decision making factor is "desire" instead of "knowledge."

One of the most difficult aspects of flight safety education is the conversion of skeptics into believers. Aircraft accidents will generally accomplish this, but only if the person being converted is involved in the accident himself or has a close friend involved in one. Needless to say, this is the undesirable way.

A pilot must know <u>where</u> and <u>how</u> he is liable to be involved in an accident. Not just in relation to emergencies and other obvious pitfalls, but in relation to the situations and environmental atmospheres that precipitate emergencies and potential accidents. These are the subtle and subconscious causes of accidents, and they are the most heinous of all the causes in that they are so obvious and plain, but yet so nebulous.

We are all human, and because of this, we share common failings. There are three main peculiarities of the species "Pilotorum humanis" that account for the majority of aircraft accidents. Do not deny these manifestations of human nature, because you have them like the rest of our breed. If you have not noticed them by now, you will eventually...

The first of these peculiarities is the fact that men tend to be prouder of their willingness to take a chance than of their caution, conservation, and carefulness. No doubt many of us can recall flying in marginal weather to make that date or stretching our fuel supply to avoid a refueling delay, or even attempting hazardous flights in aircraft we are not fully qualified to be flying. Sure, we all made it. From the stories we hear, we would think the odds are predominantly in our favor, but are they? Unfortunately, testimony to the contrary reposes quietly in flight safety files under the heading of "Pilot Factor."

While remembering these talks of daring episodes, how many can remember the times you have heard of canceled flights because of weather or of diverting before reaching the destination because of

low fuel? Not many, I'll wager. Why? Because it is human nature to romanticize, to startle, to glamorize. Flying is a romantic business. It is so because it is hazardous.

Any profession that involves hazards over and above those encountered in the more common occupations is romantic. Who does not admire the bull-fighter, the mountain climber, the auto race driver? There is an undeniable human tendency to romanticize the risk-taker more than the man who figures a way to avoid the risk.

To what does this all add up? Simply this: conservatism and caution must compete with a subconscious tendency to regard these qualities as a form of timidity unworthy of a pilot.

The second undesirable peculiarity of human nature is the fact that men tend to use their powers of logic and reasoning to find justification for the things they want to do rather than to determine what is best to do. In other words, we tend to compromise our better judgment in favor of our desires by rationalizing.

Basically man is a creature of emotions, feelings, impulses, and unrecognized urges, all kept under precarious control by a flimsy bridle of intelligence, rationality and logic, and the painful whip of authority and social pressure. Most of us, when confronted with a problem involving a conflict between what we know we should do and what we would like to do, tend to seek a way to satisfy our desires while convincing ourselves that it is the proper thing to do.

"I'd sure like to get back to play in that golf tournament this weekend, but the weather looks pretty mean," we say. "What the heck, I need some weather time anyway, and if I stay low I probably won't get any icing." This is rationalization. "I'd like to get home. I know the weather is bad and I shouldn't go. Anyway, I need some weather time. How convenient. Warm up the golf sticks, I'm on my way!"

When man's basic nature, his fundamental urges and strong desires pull him toward one decision, and his education inclines him toward another, all too frequently he will go with his feelings.

Now the third undesirable characteristic of man is this: men will risk losses out of all proportion to possible gains if they feel that through their skill and luck they can probably avoid the loss. Why do people in automobiles attempt to pass on hills or blind curves? Why do pilots flying a poor landing approach go on and attempt to land when they know they should go around? They know better. Why do they do it?

Why? Simply because it is one of those undesirable human quirks. What is to be gained and what is to be lost? A few minutes' time in the case of the former, a life in the case of the latter. What gambler would

play odds like that? Still, if someone asked if you were a gambler, how would you answer?

If you were to sit with a man in his living room and give him these situations, he would tell you he would do the safe thing. But put him in one of the above situations and see what he does. More than you would expect will gamble. It is human nature, and it comes back to the old conflict of knowledge versus desire.

Being a pilot is a hazardous profession, but it is only as hazardous as you want to make it. Control your desires, and be aware of the traps human nature has laid for you. In years to come, remembering what you have read here may save your life.

Approach/September 1972 as reprinted from
ATC "Approach to Safety"

*****

REACTIVE CHEMICALS COMMITTEE

Joe Milner, Safety Director
Holston Defense Corporation
Holston Army Ammunition Plant

Many chemical processing industries can obtain maximum safety reviews of the chemical products they manufacture, handle and store through the efforts of a special committee set up to classify chemicals purchased or produced in larger than laboratory quantities.

Chemicals are classified as reactive, nonreactive, nonreactive special or undetermined. In classifying a chemical, the committee uses a survey sheet, indicating the name of the chemical, the classification of the chemical as to reactivity, the product and material number, the molecular formula, and the structural formula. The entire sheet, with the exception of the Health Hazard Section, is filled in and approved by the committee. Any supporting data such as Differential Thermal Analysis (DTA) curves, sales bulletins or other sources is attached to the survey sheet for filing. After approval, the forms are sent to the Recorder of the Reactive Chemicals Committee, who, at Holston, is the Contractor Safety Director.

Classifications

1. Reactive Classification (R). A reactive chemical is a substance which, by virtue of polymerization, condensation, explosion or decomposition is potentially hazardous in mixtures which occur by design, or which may occur by accident, in manufacturing processes. Chemicals which are hazardous because of flammability in the ordinary sense are not regarded as reactive unless such chemicals in mixtures may explode under pressure in the process concerned. If the committee classifies the chemical as reactive, each of its reactive features should be noted on the form, along with the references substantiating the reactivity.

2. Nonreactive Classification (N). This classification will be used for all chemicals not classified as reactive, undetermined or nonreactive special.

3. Nonreactive Special Classification (S). The nonreactive special classification is to be used for those chemicals which are normally nonreactive but which would create a hazardous condition with a specific chemical. The specific reaction must be noted and the resulting specific hazard must be noted.

4. Undetermined Classification (U). If the committee is unable to classify the chemical as either reactive or nonreactive, the classification will be listed as undetermined. The reasons for this classification should be explained under the Comments section of the form.

The committee reviews a chemical classification at any time new information concerning it comes to their attention. Members of the committee or others in the plant may send new information regarding reactivity of a chemical to the Recorder, who, after review, will make the necessary revisions or additions.

The duties and responsibilities of the committee can best be listed as follows:

1. Coordinate the classification of chemicals including the provision of a reporting form (Reactive Chemical Survey Sheet).

2. Audit organization procedures and controls within divisions to implement safe practices with reactive chemicals and chemical processes.

3. Review and approve the reactivity classification of chemicals.

4. Disseminate appropriate chemical hazard information to concerned departments.

5. Prepare after each meeting, minutes of committee actions.

6. Periodically inspect, study, and review all materials, existing operations, plant changes or expansion, and projects existing or being considered for development.

7. Take whatever action necessary to report to the appropriate division head findings of a reactive nature and follow-up to be sure that corrective actions have been taken.

8. Review any capital project wherein the committee should be appropriately concerned prior to submission of the Request for Job Order to management for approval.

9. Classify all chemicals purchased or produced in larger than laboratory quantities as to their reactivity.

10. Review all accidental incidents involving reaction of chemicals, formulate recommendations to prevent recurrence and report the results of the review to the Plant Manager.

11. Offer consultation service whenever a suspected chemical hazard exists in its area of responsibility. The committee will also review certain accident prevention items (at the discretion of the committee chairman) and give their recommendations.

12. The committee will review for hazard evaluation existing and new manufacturing processes, storage facilities and methods of handling chemicals and other materials used. Proposed significant changes in manufacturing processes, storage facilities and handling methods will also be reviewed by the committee.

The Health Hazard section of the Survey Sheet is completed by the Medical Department.

It is suggested that the committee be composed of a member of Management, a chemical engineer, a chemist, representative of the Engineering Department, Safety Department representative, and a representative of supervision from each department or division that stores, handles or manufactures chemicals.

*****

NOISE IN THE HOME

While most of us are concerned with the exposure of personnel to noise sources on the job, the use of convenient and sometimes necessary appliances constitutes a growing noise problem within the home.

A study prepared by Bolt, Beranek and Newman under contract for the EPA shows the sound levels for 30 types of home appliances and 11 types of home shop tools. Sound levels were measured in dB(A) at a distance of three feet from the appliance and at a height of five feet. This measurement position approximates the location of the operator's ear for those appliances requiring an operator.

Noise levels in adjacent rooms with the interconnecting door open may be as much as 10 dB(A) less than the levels of three feet or as much as several dB(A) greater than the 3-foot levels, depending upon the details of the installation. For the appliances that are used near the ear (e.g., an electric shaver), the noise level of the ear may be as much as 10 dB(A) greater than the 3-foot measurements. See Figure 1.*

If you were to operate more than one noisy small appliance at once, it is easy to see how you could be exposed to an excess of 85 dB(A) in your own home.

Eighty-five dB(A) is the sound level above which a hearing conservation program should be in effect at Army installations according to TB MED 251. Take, for example, a food blender operating at 80 dB(A) simultaneously with a food waste disposal operating at 80 dB(A). The resultant sound level is 85 dB(A).

Figure 2* shows, on the basis of the number of people exposed and the extent of exposure, the speech and sleep interference and hearing damage risk associated with the various appliances. Hobbyists, for example, who engage in the regular use of power tools are accepting a moderate hearing damage risk if they do not wear adequate protection.

Noise is a growing problem in our communities. Almost without exception, appliances could be significantly quieter. Many manufacturers have been slow to implement noise control measures in the design of their appliances. However, in keeping with the public's growing awareness of noise, many appliances can and will be improved. Let's do our part to make people aware of the hazards that surround them at home as well as on the job.

---

* Figures 1 and 2 were extracted from Report #NTID 300.1, U. S. Environmental Protection Agency, Washington, D. C.

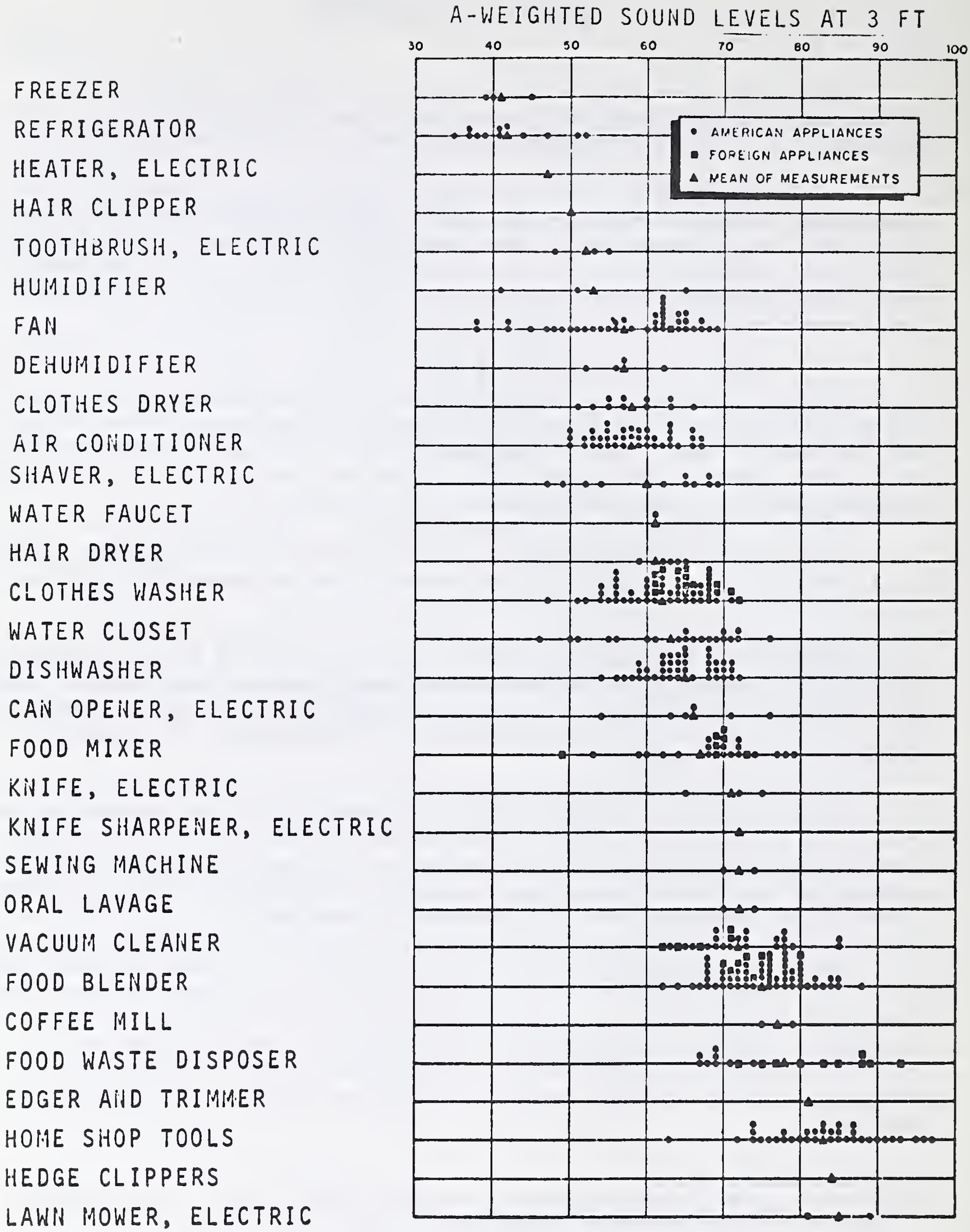


FIG. 1 A SUMMARY OF NOISE LEVELS FOR APPLIANCES MEASURED AT A DISTANCE OF 3 FT.

FIGURE 2 ORDER-OF-MAGNITUDE ESTIMATES OF EXPOSURE TO HOME APPLIANCE AND BUILDING EQUIPMENT NOISE EXPRESSED IN MILLIONS OF PERSON-HOURS PER WEEK

Noise Source	Speech Interference		Sleep Interference		Hearing Damage Risk	
	Moderate (45–60)	Severe (>60)	Slight (35–50)	Moderate (50–70)	Slight (70–80)	Moderate (80–90)
Group I: Quiet Major Equipment and Appliances						
Fans	1200		0		0	
Air Conditioner	242		121		0	
Clothes Dryer	94		10		0	
Humidifier	10		15		0	
Freezer	0		0		0	
Refrigerator	0		0		0	
Group II: Quiet Equipment and Small Appliances						
Plumbing (Faucets, Toilets)		535	267		0	
Dishwasher		461	4		0	
Vacuum Cleaner		280	0.5		0	
Electric Food Mixer		222	1		0	
Clothes Washer		215	0.5		0	
Electric Can Opener		117	0.2		0	
Electric Knife		1	0.1		0	
Group III: Noisy Small Appliances						
Sewing Machine		19		0.5	9	
Electric Shaver		6		1	5	
Food Blender		2		0.2	0.5	
Electric Lawn Mower		1		1	0.3	
Food Disposer		0.5		0.5	0.5	
Group IV: Noisy Electric Tools						
Home Shop Tools		5		2		1
Electric Yard Care Tools		1.5		.1		0.4

CURRENT EVENTS

PICKUP SANDWICHED BY TRUCKS

Two Army civilian employees were en route to a work assignment in a half-ton pickup truck. The driver approached the main gate of their duty station, and slowed to make a left turn onto the post.

The entrance of the gate was blocked by a truck-trailer unloading gravel. The driver saw another truck-tractor approaching from the south with his right turning signal flashing. The Army driver thought the on-coming truck was going to enter the construction area and pull behind the truck that was blocking the entrance. The Army civilian driver made a left turn in front of the approaching truck-tractor, which continued straight ahead instead of turning.

The truck-tractor struck the pickup in the side, bouncing it against and partially under the parked truck-trailer. Photo 1 shows the final resting place of the Army pickup truck and damage to the parked vehicle. Photo 2 shows the extent of damage to the truck that struck the pickup.

Photo 1

Photo 2

Both the driver of the Army pickup and his passenger suffered multiple fractures and lacerations. Damage to the Army vehicle was estimated at $2,396, and the commercial vehicles sustained a combined damage of $10,800.

Contributing factors to the accident were:

1. No traffic controls had been established to warn motorists that construction work was in progress.

2. There were no warning signs or flagmen in the area.

3. The area was heavily congested with construction equipment and other vehicles.

4. The driver of the Army vehicle disregarded traffic laws by failing to yield the right-of-way.

Warning signs or flagmen will be placed at construction areas in the future. Also, continued effort will be made to caution operators of Government vehicles to exercise extreme caution while driving.

*****

OVERTURNING FORKLIFT PINS OPERATOR

A forklift operator was transporting palletized material from one location to another with a 4,000-pound capacity forklift truck.

The operator was making a right turn when the right front tire of the forklift truck hit a concrete barricade that guarded a fire hydrant. This caused the forklift to overturn. The operator was pinned across his shoulders and neck by the overhead guard. Fellow employees lifted the forklift off the injured. He suffered chest and cervical spine fractures.

No mechanical defects could be found.

The operator was cited for failing to maintain a proper lookout, and being inattentive to operating responsibilities.

He was to be removed from the forklift operation detail, and attend a forklift operator remedial and refresher training course before being reassigned to similar tasks.

*****

JUST A LITTLE BIT OF PRIMER MIX

An operator had finished his charging production assignment for the work shift and was preparing to remotely dump the remaining three to four ounces of dry primer mix into a non-conductive salvage cup. When removed, the contents of the salvage cup are immersed in water for disposal.

As he positioned himself to dump the remaining dry mix, he noticed the salvage container was out of position. He opened the side-barricaded cubicle door, held it open with his left hand and pushed the salvage container into proper position with his right hand. The explosion occurred at this point.

The operator suffered a minor laceration of the forehead. The equipment was severely damaged, and some damage was done to the blow-out walls and other facilities. Estimated property damage was $2,680.

Established procedures for malfunction inside the cubicle are:

1. Inform supervisor of the unusual occurrence. (Employee had reported the salvage cup being out of position twice during his work shift. The supervisor planned to make necessary adjustments after the area was completely decontaminated at the end of the shift.)

2. Dump the remaining powder into a rubber bucket containing three gallons of water.

3. Operate the deluge system to completely wet down all existing powder inside the cubicle.

The operator failed to follow instructions when he repositioned the salvage cup, since these cups are never to be moved from their position after the machine hopper has been charged.

No exact cause of the accident was established, except that the operator entered the cubicle when explosives were present and repositioned the salvage cup with his hand.

Corrective actions to preclude recurrence of such an incident are as follows:

1. An engineering revision will be made to eliminate possible misalignment of the salvage cup on the dumping fixture.

2. An additional mirror will be provided inside of and to the rear of the charging unit for improved observation of the operation through the view port.

3. Operators will be reinstructed to inform supervision of any unusual occurrences to units inside the cubicles.

4. Daily inspections of all remote controlled units prior to insertion of explosives will be established. An inspection of a "dry run" is to be conducted by responsible persons.

*****

FIRING PIN FIRES DETONATOR

A routine Government Acceptance Test was being performed on M57E1 detonators. The inspector was in the process of inserting the firing pin into the assembly when the detonator exploded. He suffered partial amputations of his left thumb and forefinger, a severe laceration of his left middle finger, and a large bruise on his right thumb. There was no property damage.

The established procedure consisted of preparing an assembly of a detonator, an aluminum sleeve, a plastic holder and a metal witness block (disc). This assembly is then placed in a die inside the drop-test machine. This unit is then rotated 90^{o} from its vertical position to a horizontal position. After a firing pin is inserted into the assembly, the drop-ball is then positioned on the magnet. The door, which serves as a guard, is then closed. Ensuingly, the assembly is returned to its original vertical position. The drop-ball is released which drives the firing pin into the detonator, thus causing the explosive functioning.

Observations made by investigators were as follows:

1. The injured man was holding the test assembly with his left hand as he inserted the firing pin with his right hand. The pin inserting operation does not require the use of the left hand; however, the operator stated that he occasionally used his left hand but could give no reason why he did so.

2. All safety devices were in good condition; i.e., guards, finger stop, test holder unit, etc.

3. The firing pin cannot be inserted too deeply if the test assembly is in the complete horizontal position due to the position of the "finger" stop block.

4. Posted job rules and procedures are current, correct and readily available.

5. The injured had been thoroughly instructed, and had been a fuze tester for approximately nine years and had not experienced any previous incidents of this nature.

It was concluded that the operator may have used his left hand to hold the test assembly when inserting the firing pin instead of using the "Finger Stop Block" as required by the standing operating procedure. It was also suspected that the firing pin was inserted at some position other than with the assembly in the horizontal position.

The following recommendations were made to prevent recurrence of this type of accident:

1. Discontinue the manual insertion of firing pins from within the drop-test unit. Use the two available detonator test units which permit insertion of the firing pin from outside of the unit.

2. Redesign the other machines to allow insertion of the firing pin from outside the guarded machine for testing boosters and detonators.

3. Investigate the possibility of fabricating a completely new type testing unit and/or method.

4. Schedule weekly "check-out" by foremen for each employee with special emphasis on rigidly adhering to established procedures and job instructions.

5. Publicize accident factors throughout the installation.

*****

LADDER SLIPPED, WORKER FLIPPED

A utilityman had been assigned the task of removing paper lining from the interior of a commercial boxcar.

He used a 7-foot ladder that was not equipped with safety shoes. The floor of the boxcar was metal. It was dry, but slippery, due to continued use.

When the man had climbed approximately five rungs, the ladder slipped causing him to fall to the floor of the boxcar. He suffered a fractured left wrist.

To prevent future accidents of this type, new 8-foot step ladders with safety shoes will be provided for men assigned to work in boxcars. In addition, the incident was discussed in group safety meetings by all foremen.

PRESSURE TANK EXPLOSION — LIQUID NITROGEN SYSTEM

Summary

At an AEC contractor facility, a vertical, mild steel tank (24" diameter X 60" high, and weighing approximately 135 pounds) became over-pressurized, ruptured, and was propelled approximately 150 feet into the air. It came to rest on the roof of a building some 75 feet from the location where it had been installed. The tank was being used as a surge tank in a laboratory liquid nitrogen system, which was designed to provide pure nitrogen to the second stage of a 6-stage, 10,000 psi compressor for an 18-inch hypersonic wind tunnel.

The force exerted by the overpressurization blew the welded concave bottom completely out of the tank; pulled a ½-inch anchor bolt from its concrete foundation; twisted the heavy angle iron base on which the tank was seated, and scattered the piping over the confined yard area.

There were no injuries and property damage was slight. The only loss was the tank, associated piping, and a small hole which was punched in the roof of the building. However, the incident had the potential for resulting in multiple serious or fatal injuries and/or extensive property damage.

Cause of the Incident

Investigation showed that the system, which had been operating in its present condition for less than six months, had been installed with an unmarked pressure surge tank which had no pressure relief valve or rupture disc. A pressure relief valve had been installed in the piping approximately 30 feet from the tank; but two solenoid valves which had been installed between this relief valve and the surge tank had isolated the tank from any safety relief protection.

A regulator had been installed in the nitrogen supply line between the vaporizers and the surge tank; however, because of downstream losses in the line and the fact that the installed regulator was undersized, the regulator had been opened to almost its full capacity to provide the necessary 30 psig for the compressor. The using organization, while aware that the regulator was undersized, had continued to operate the system by manipulating the regulator rather than shutting it down pending installation of a regulator which would provide the necessary flow at a proper setting.

When the compressor would automatically shut down, the solenoid valves in the line would close; and without flow, the pressure in the surge tank (which was designed for 50 psig maximum allowable working pressure) would

increase to 80 to 100 psig. This increase in pressure was caused by the fact that the undersized regulator was at a setting during flow which approximated 100 psig during static conditions.

The using organization stated that they were under the impression that the surge tank had been designed for a working pressure compatible with the system and were, therefore, unconcerned about this pressure rise.

Recommendations

The importance of having all pressure systems properly designed, installed, and maintained and the need for stringent safety procedures for their operation, even when only a few pounds of pressure are involved, cannot be too strongly emphasized. For this reason, it is recommended that any type of pressure of vacuum equipment receive a thorough independent review by a member of the safety group prior to startup and prior to modifications to existing equipment. If any questionable safety aspects arise after the equipment is put into use, the operation should be shut down and the line supervisor should enlist the help of the appropriate member of the safety group.

- Serious Accidents, Issue No. 328
  19 July 1972
  Division of Operational Safety
  US Atomic Energy Commission
  Washington, D. C. 20545

IT'S SNOW TIME AGAIN! (Cont from page 1)

• Think over the techniques of driving on snow and ice. NEVER slam on the brakes! When you have to stop, let up on the gas slowly and pump the brakes gently -- that means start stopping long before you get to an intersection, and as soon as you realize you may have to stop for any other reason. As you approach an intersection, watch it! The fellow approaching from your right or left may not be able to stop before sliding on out into your path.

• If you should go into a skid, turn the wheels in the direction of the skid and slowly let up on the gas. Above all, don't panic!

Yes, you've heard all these things over and over again. And you'll probably hear them all again next winter, and the next. But isn't that what safe driving is all about -- knowing exactly what to do in an emergency -- and not having to stop and think, "Oh gosh, I'm going into a skid and this is glare ice! Now what was it I heard that time five or six years ago about what to do when this happens?"

THE SAFETY GAP

Edward M. Klinghoffer
Safety Engineer, Picatinny Arsenal

Today, when we speak of science and technology racing ahead of us, we sometimes forget that this problem has been around ever since man started thinking of new ways for doing things.

We should remember that it took 5,000 years from the time man first learned to ride on horses until the time that man first developed a safety device for this practice. This device, invented during the Middle Ages, was called the saddle. A seemingly obvious idea certainly took a surprising amount of time to develop.

For another example, let us look at ships. Before the dawn of recorded history, man built and sailed on ships. Yet ships were not commonly equipped with life boats until the 19th century. You may recall that there were only enough life boats for half of the passengers and crew of the Titanic when she sank in 1912.

In the case of the railroad industry, it was more than one hundred years after the steam locomotive was first used for transportation that George Westinghouse invented the air brake to stop railroad trains safely. Supposedly, the source of his inspiration was a disastrous train wreck which was reported in the newspapers of the time.

Another example would be the airplane. Although the airplane was finely developed as a combat weapon during World War I, it was not until some time after the war was over that the parachute was perfected and widely used. Many lives were lost needlessly as a result.

"Well," you say, "what about the automobile? That is the form of transportation that I use every day."

It has been 50 years since automobiles came into common use on the streets and highways of this country. Yet even today, safety devices have not been perfected to completely protect the motor vehicle driver or his passengers from injury in a collision. All that we can do, is to use the safety devices that are available at the present time.

Many examples, similar to those we have discussed, can be found in every field of scientific development. It is a challenge to the safety profession to close the "safety gaps" as they occur in new technologies and to teach people to protect themselves until these gaps are closed. Only in this way, can we learn to live with the rapid technical advances that are so much a part of our lives today.

SELLING SAFETY IS AN EASY JOB

Tommy Bales, Leader
Remington Arms Co., Inc.
Lake City Army Ammunition Plant

Before coming to work here at Lake City I was a salesman; seems like I can't get out of the habit of selling, because today I'd like to sell you something. It is something that is guaranteed to be the best on the market, and something which every one of you can see.

That something is safety.

Safety is cheap: it is something that everyone can afford because it costs only a second of your time, a second in which to stop and think and be careful. There are 86,400 seconds in 24 hours and surely each of us can afford to spare a few of those for safety.

Safety is easy to get: you don't have to write a letter and order it; you don't even have to walk to the corner drug store to get it; it is with you all the time; all you have to do is use that one short second to buy all you need.

Safety is durable: you can use it every day, at home and on the job, and it will never wear out; it will always be with you ready to be used again the next time you need or want it.

And safety is convenient to use: it doesn't have to be unwrapped, unpacked, heated or chilled; safety is ready for use whenever you are ready to use it; all you have to do is take one tiny second to stop, think and be careful.

These, then, are the four points in my safety sales talk:

1. Safety is cheap -- much cheaper than a few days or weeks in a hospital.

2. Safety is easy to get -- much easier to get than a broken arm or leg.

3. Safety is durable -- much more so than an artificial limb.

4. Safety is convenient -- a lot more convenient than using a cast or bandage.

So don't wait, don't hesitate, buy safety today. Buy the large economy size; it doesn't cost a bit more.

And, you might try being a salesman too. Sell some safety to your friends and families. They can use it.

Editor's Note: This is a reprint of a talk made in an employee safety meeting by Mr. Bales and subsequently published in the December 1951 issue of the "Lake City Tracer", Lake City Army Ammunition Plant, Independence, Missouri.

ZERO IN ON PROMOTING SAFE PARTICIPATION IN SPORTS AND RECREATION

Webster's New World Dictionary defines promotion as the stirring up of interest in an enterprise. As a safety professional, do you accept this definition at face value and stop there? Is your safety promotional effort restricted to only "stirring up interest"?

A safety director's need, his requirements, for promotion go much further than that. To him promotion is a means to an end, a method of achieving a result. Promotion must encompass more than stirring up or stimulating interest. Promotion must influence behavior and promotion must prompt or provoke a desired action. Promotion to the safety director must yield results.

Too much emphasis has been given to the embellishment of safety promotion -- to the "window dressing" or ornamentation -- to the posters and pamphlets and attention-getting gimmicks. This decoration plays its part, but decoration must not serve as the entire promotional program. Handouts, pamphlets, posters and displays play a role in influencing employee behavior, but too often our promotional emphasis stops there. The safety professional needs to actively influence behavior, not just hope a poster message soaks in! Anything we can do to influence employee action toward the desired results must be used in promotion.

Recent safety emphasis within AMC has been directed toward reducing the number and severity of sports and recreation accidents. Let's apply the above broad, professional idea of safety promotion toward promoting sports and recreation safety. In addition to posters, displays, handouts and pep talks, let's see what can be done to stimulate safety participation in sports and recreational activities.

The safety director, supervisor, coach or company commander knows that the cooperation and support of sports participants in performing safely are necessary. Self-responsibility must be developed in participants so the activity will be performed safely whether at Army-sponsored special services athletic events or at spontaneous and impromptu "sand-lot" games.

Promoting safe attitudes. Most people will obey rules they understand. On the other hand, usually they will not obey rules they do not understand or do not see the need for. The participants should not be simply presented a list of "do's" and "don't's" prescribing safe and dangerous behavior without the logic behind the rules.

Most participants will obey safety rules if they are convinced the rules are a prerequisite for participation. Safety rules should be strictly enforced and the value of the rules in increasing the enjoyment of the sport should be emphasized. Coaches, supervisors, Commanders, etc., also can help develop participants' respect for safety rules by setting good examples.

Promoting self-discipline. Participants must learn to govern themselves in their own best interests. External authority and control will not always be present. In order to develop personal responsibility for safe performance, participants must be given opportunities to plan, execute, and evaluate their own performance and conduct. One method of accomplishing this is to have participants assist in developing a safety code and safety rules. Participants should also be encouraged to assist in enforcing safety codes and rules. Participants might be assigned responsibilities for inspecting equipment and facilities, helping beginners learn basic skills, and supervising certain sports activities.

Promotion through the basic laws of learning. We must promote the safe way to perform various athletic skills rather than employ the method of having participants "learn" how to avoid accidents by first suffering accidents. The basic laws of learning can be successfully used in the promotion of safe performance of sports activities:

1. Law of Use -- The more a basic skill is practiced, the more proficient the individual becomes.

2. Law of Disuse -- If a skill is not performed for a certain length of time, proficiency will decrease.

3. Law of Effect -- Skills that are satisfying will be repeated, while annoying skills will be avoided.

4. Law of Primacy -- First experiences are more likely to be remembered than later ones.

5. Law of Recency -- Recent experiences are more likely to be remembered than remote ones.

Promotion through the use of basic human needs. Self-preservation is perhaps the most basic human drive. Emphasis in safety promotion should be placed on avoidance of injury rather than avoidance of the accident itself. Participants will be quick to accept safety practices when they realize an injury will prevent them from participating.

Safety promotion should stress the importance of each individual's contribution to the group effort. An injured player cannot contribute to the group, and each individual strives for group acceptance by contributing to the goals of the group.

Most persons desire responsibility as a form of recognition. Individual participants should be delegated as much safety responsibility as they are capable of handling. Promotion should emphasize the need for assuming self-responsibility.

Personal pride can be used to promote safety by having outstanding players demonstrate the safe way to perform specific skills and exercises. Other participants will be more likely to accept safety practices if they see that the outstanding players practice them.

Individual and group safety competition can be generated and maintained by rewarding individuals and groups who have accident and injury-free records.

Additional promotion methods. There are several additional major methods of promotion which can be advantageously employed in developing safety practices in sports and recreational activities:

1. Demonstration -- Demonstration is the basic method used in developing skill, and any satisfactory method of developing skill is a method of promoting safety since the proper way to perform a skill is also the safe way.

2. Imitation and practice -- After observation of a skill demonstration, participants should practice the skill. Coaches and supervisors should observe each individual and correct any mistakes in execution.

3. Army Extension Course -- Subcourse #45, Safety in Physical Training, Sports and Recreation, outlines the fundamentals in preventing accidents and injuries while participating in sports and recreation.

*****

HOW TO BLOW UP A PLANT WITHOUT DAMAGING IT

M. J. Reynolds, Explosives Manager
Uniroyal, Inc., Joliet Army Ammunition Plant

My subject for today sounds impossible, doesn't it? Really, my discussion will center around the Carmody Universal Process Trainer that we have selected for use at Joliet Army Ammunition Plant. It has been specifically selected and obtained for use in preparation for start-up of the three new modern acid facilities and the three continuous TNT lines presently under construction. Potential of this unit is not limited to the modern facilities, however. Its flexibility makes it possible to set up any chemical operation within the plant and assimilate it within a 95% to 100% accuracy tolerance.

Because training by simulator allows operators to "blow up" a plant any number of times while in training, they are less likely to do so when it counts.

The column's temperature indicator began to rise. "A triviality," thought the operator as he adjusted the control valve. But the indicator continued to climb. In addition, the fuel supply pressure indicator began curving upward. "I don't remember any relationship between these two indicators," the operator muttered as he twisted the pressure knob. Now the temperature and pressure were shooting up. "I'd better open the valve in the relief line," the operator gasped. But it was too late. "You just blew up the plant," his supervisor scolded -- and then laughed. Everyone else in the room joined in. They were laughing only because the operator had been operating the panel instruments of a process training simulator, and not of an actual plant.

What Is A Process Simulator?

Basically, a process simulator is an electro-mechanical medium for two-way communication between an instructor and a trainee being taught the intricacies of controlling a chemical process.

Physically, it consists of three main parts:

1. A graphic display panel.

2. A main instrument panel.

3. A control console.

Among the accessories are interchangeable instrument modules, program boards, alarms and connecting cables.

Trainees depict the process they are to study by means of equipment symbols and flowlines, which attach magnetically to the graphic panel. This not only helps them learn the relative location and relationship of the process components, it accelerates their understanding of the operation. During training sessions, the display panel also serves as a ready reference for flows, control locations, and equipment configurations.

Modular construction enables the instructor to change from one process to another in a matter of minutes. The actual control panel for any process can be accurately copied with the interchangeable instrument modules and fixed multipoint indicator.

Trainees set up the easily mastered program boards from appropriate drawings. Instruments can be operated automatically through these boards to show instrument relationships and alarm functions, or they can be operated individually from the control console. Malfunctions and emergencies can be introduced automatically through the program board, or by the instructor directly from the control console.

Trainees learn by doing, with guidance from the instructor as he, from the control console, sets up normal and emergency process conditions on the simulator. Whereas the instructor improvises, the relationships previously set up on the program board occur automatically.

The trainee's responses provide immediate feedback, which enables the instructor to regulate the pace of training for maximum effectiveness. The instructor changes output signals, alters process variables, sets off alarms, causes motors to fail and simulates malfunctions to create realistic control room circumstances.

Advantages of Training by Simulation

An operator may experience only a few emergencies in his entire life. When he is trained by simulation, however, he can go through a dozen emergencies in a single day. Unlike conventional training, training by simulation is almost as real as experience.

Training by simulation enhances versatility. Most conventionally trained operators know only how to operate a single process. By means of simulation, however, an operator can be prepared to perform a variety of operating tasks in addition to his regular assignment.

Much conventional training involves learning by rote. Consequently, many operators, even those who have had on-the-job training, only know, for instance, that a certain valve must be opened when a particular gage indicator reaches a specific point, but they never learn why. On the other hand, whether the training is basic, intermediate or advanced, training by simulation ensures that operators acquire a depth of knowledge not possible with other training methods.

Faced with a sudden emergency, the simulator-trained operator is more likely to handle emergencies with confidence because he will have encountered more of them than an ordinary operator with years of experience.

Training by simulation gives operators a chance to demonstrate their knowledge and skill, an opportunity generally absent in conventional methods. As a trainee progresses, his desire increases for more knowledge, and he is motivated to work out problems and procedures on the simulator.

Good motivation implies high morale. A well-trained operator enjoys greater job security. He also appreciates the importance of doing his tasks well. He knows that his efficiency means fewer unscheduled shutdowns, shorter turnarounds and higher quality product.

Documented experiences of major industries of the world have found profitable applications for the Carmody training approach. One large corporation is reputed to have 17 simulators integrated into its manufacturing department.

As a Safety Committee, one of the more important statistics would be to claim, "facility unharmed while plant is destroyed three times on trainer."

Some of the reasoning supporting our decision to go this route can be outlined as follows:

1. First, the technological changes in the chemical industry have led to highly instrumented equipment and larger process units where operator mistakes can be extremely costly.

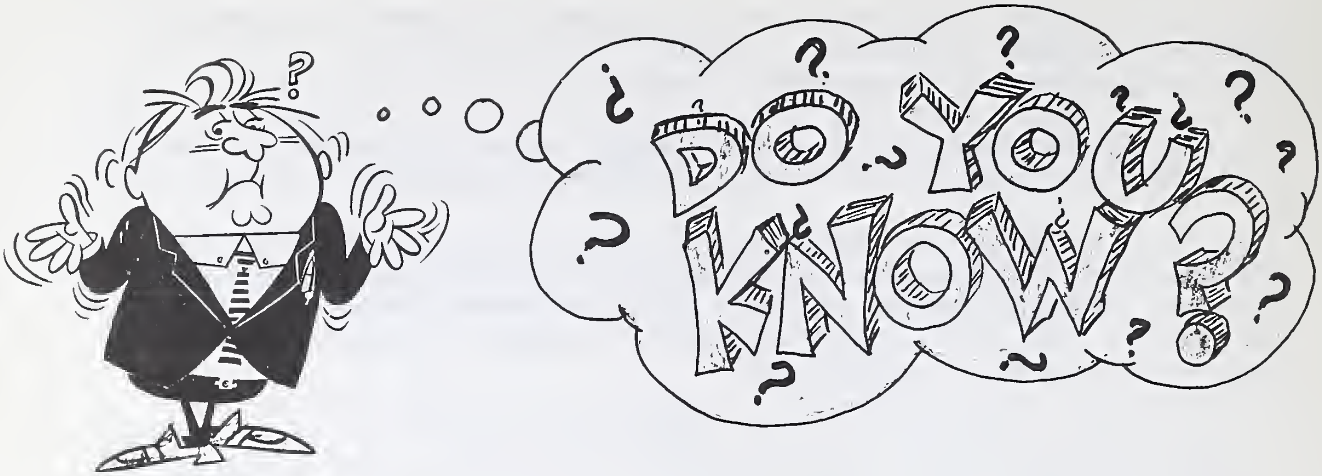
2. The industry has become highly competitive making it essential that every employee is utilized to the maximum of his ability.

3. The type of labor available has changed. Previously, unskilled labor of reasonable caliber was satisfactory; this is no longer the case. We can, however, develop proper aptitudes, people with slightly less than a high school education, into satisfactory operators with this instruction and their cooperation.

*****

ANNISTON ARMY DEPOT
WINS NATIONAL SAFETY COUNCIL AWARD OF HONOR

Anniston Army Depot was the recent recipient of a National Safety Council Award of Honor for operating more than 5,500,000 man-hours without a disabling injury. Shown admiring the award plaque are COL M.E. Rice, Commanding Officer; Faye Richey, Civilian Personnel Division; and Ginger Fair, Lance Fueling Facility.



Here are ten questions that will test your knowledge of safety requirements that you will need under different circumstances. Answers to these questions may be found in the AMCR 385-series, the AR 385-series and the AMC Supplements to the AR 385-series. How many can you answer without referring to the regulations?

1. What immediate action must be taken by the safety director when an accident occurs at his installation?

   Answer and reference:

2. What are the approved lightning protection systems for use at an AMC installation?

   Answer and reference:

3. What basic procedures should be followed as pertains to materials handling?

   Answer and reference:

4. Is heating of explosives storage magazines ever permitted?

   Answer and reference:

5. What factors are considered when grouping ammunition and explosives for compatibility?

   Answer and reference:

6. Of what does a thorough fire inspection consist?

   Answer and reference:

7. For accident reporting purposes, what constitutes an "Explosive Accident?"

Answer and reference:

8. What is the procedure for AMC installations and activities to follow in submitting the monthly DA Form 2398?

Answer and reference:

9. What are the requirements for explosives plant clothing; i.e., powder uniforms?

Answer and reference:

10. What are the minimum dimensions for the doors in a building containing explosives?

Answer and reference:

*****

TOOELE ARMY DEPOT WINS NATIONAL SAFETY COUNCIL AWARD OF HONOR

Tooele Army Depot was the recent recipient of a National Safety Council Award of Honor for having achieved more than 7,000,000 man-hours without a disabling injury. COL Ralph C. Robinson, Commanding Officer, Tooele Army Depot, is shown accepting the award from Depot Safety Director, Lyle E. Colbath.

THE SHOCKING FACTS

Does a 3-wire system in portable appliances, extension cords, etc., insure protection against electrical shock? If your answer is emphatically "Yes," you should give some additional thought to the question. Given a few moments for the additional thought, you might possibly add, "Yes, if....," and the remainder of your statement should convey that 3-wire systems will only provide that degree of safety equivalent to the system's original construction and continued maintenance.

A case in point is a recent AMC accident involving the use of a 3-wire electric drill and extension cord. The worker was wearing electrical safety shoes while standing on a dry surface, and was still severely shocked. How can this be with a 3-wire system? In this particular case, the extension cord had an exposed hot wire at the connector. (See photo at right.) The worker evidently came in contact with the hot wire and at the same time made contact with the body of the drill. This allowed current to flow from the hot wire through his body to the third wire grounded drill. Result? ....One disabling injury.

How can recurrence of this type accident be avoided? AMCR 385-100, paragraph 6-21, gives us that answer as follows:

"Because of the necessity of safeguarding persons against the hazards of defective portable appliances, cords and plugs, more than ordinary care shall be exercised with regard to their maintenance.

"1. Each portable appliance shall be assigned a number and shall be inspected and tested by a qualified individual on a regular schedule.

"2. The frequency of tests shall be determined by the degree of service, and shall be in sufficient detail to uncover any defects.

"3. A written record of the tests, defects found and repairs made shall be kept.

"4. It is recommended that the maintenance inspections and tests be made by qualified personnel of the electrical department and that spot checks of the equipment against the records be made by a member of the Safety Office.

"5. Employees about to use portable appliances should examine them for obvious deficiencies in the appliances, the <u>cords</u> and <u>plugs</u>. If any deficiency is noted, the appliances shall not be used but shall be returned to the electrical department for repairs."

Three-wire systems of portable appliances, cords, etc., do provide a measure of electrical shock protection. This degree of protection is surely enhanced by the proper construction of the device and maintenance on a continuing basis as outlined in AMCR 385-100.

*****

REFERENCE PUBLICATIONS

AR 385-10, Ch 2 30 Jun 72	Safety - Army Safety Program
AR 385-64 17 Mar 72	Safety - Ammunition and Explosives Safety Standards
DA Cir 385-32 27 Jun 72	Safety - Prevention of Drowning
TB 5-4200-200-10 12 May 72	Hand Portable Fire Extinguishers Approved for Army Users
AMC Suppl 1 to AR 385-10, Ch 1 3 Jul 72	Safety - Army Safety Program
AR 385-40 5 Aug 72	Safety - Accident Reporting and Records

Well, Did You Know?

Here are the answers to the questions on pages 28 and 29. A reference to the pertinent regulation and paragraph follows each answer.

1. When an accident occurs, immediate action shall be taken by the safety director to:

   a. Interview the injured person before he is sent home or to the hospital when delay of treatment will not jeopardize the injured;

   b. Visit the scene of the accident to observe conditions as they were or might have been at the time of the accident;

   c. Obtain details of the injury from the medical department;

   d. Prepare or obtain photographs, diagrams, sketches, and maps as warranted by the circumstances;

   e. Confer with foremen, supervisors and witnesses for information as to cause;

   f. Examine safety, medical, and personnel department records on the injured person's previous history, physical conditions and individual accident experience;

   g. Plan corrective measures with the foremen and other interested parties;

   h. Complete the necessary accident reports;

   i. Establish a follow-up on the application of recommended corrective measures;

   j. Follow through for exact information pertinent to the return of the injured to work.

   Reference paragraphs 1-22a through j, AMCR 385-100.

2. Approved lightning protection systems are the integrally mounted system, the separately mounted shielding system (mast type), and the separately mounted shielding system (overhead ground wire). Reference paragraph 8-2, AMCR 385-100.

3. Materials handling procedures should be in conformity with the following basic rules:

   a. Keep material moving uniformly through the process steps.

   b. Minimize unnecessary rehandling.

   c. Eliminate heavy manual lifting.

   d. Reduce transport distances wherever possible.

   e. Provide special handling equipment, such as conveyors, forklift trucks, etc., where practicable.

   Reference paragraphs 9-3a(1) through (5), AMCR 385-100.

4. Storage magazines, in general, should not be provided with heat. Exception is made in the case of magazines where heating is necessary to prevent condensation of moisture, to maintain constant temperature, or other reasons. Reference paragraph 18-5b, AMCR 385-100.

5. Ammunition and explosives are grouped, for compatibility, with respect to the following factors:

   a. Effects of explosion of the item.

   b. Rate of deterioration.

   c. Sensitivity to initiation.

   d. Type of packing.

   e. Effects of fire involving the item.

   f. Quantity of explosives per unit.

   Reference paragraphs 19-2a through f, AMCR 385-100.

6. Each part of the installation should be inspected on a scheduled basis for common fire causes such as poor housekeeping, smoking violations, excessive accumulation of flammable materials, improper storage of flammable materials, process fire hazards, blocked fire

doors and exits, seasonal fire hazards, and other fire hazards. Inspection of sprinklers, fire doors, fire exit doors, portable extinguishers, hose lines and fire-fighting equipment will be scheduled and records maintained. Reference paragraphs 12-6a and b, AMCR 385-100.

7. An "Explosives Accident" is an unplanned explosion or a fire involving explosives under Army custody resulting in one or more fatal or disabling injuries to persons, or damage to Government or private property in the amount of $ 1,000 or more. Reference paragraph 2-16a, AR 385-40.

8. Reporting commands, installations and activities will forward the original DA Form 2398 direct to the Director, AMC Field Safety Agency, to arrive not later than the 5th calendar day of the month following the month for which accident exposure is being reported. Reference Routing, paragraph 2a, appendix H, USAMC Suppl 1 to AR 385-40.

9. Explosive plant clothing must be fastened with nonmetallic fasteners and must be easily removable. Pockets must be of the lattice type. Trouser legs, slacks and sleeves should be tapered and the trouser legs and slacks shall be without cuffs, and should extend over the top of shoes or boots. The garment should fit snugly around the wrist and neck but caution must be exercised to avoid a fit around the waistband, belt, or neck sufficiently tight to cause skin irritation or dermatitis. These garments, as well as head coverings, should be made from tightly woven, smooth fabric and shall be flameproofed or made of material which has flame retardant qualities at least equal to flameproofed clothing. Reference paragraph 10-6b, AMCR 385-100.

10. Exit doors in buildings containing explosives shall, in no case, be less than 30 inches wide by 78 inches high. Reference paragraph 5-8, AMCR 385-100.

*****

THE SYSTEM SAFETY PROCESS

In the September-October issue we discussed both System Safety Testing and System Safety Application. Although the "System Safety Process" may appear to have been required before the other two articles it was thought prudent to provide some "how to do it" philosophy initially and then follow with the "process" description.

If the illustration on the next page looks familiar, it is because it was lifted from the draft revised AMC Pamphlet 385-23. It had its genesis in Chapter 3, AMC Pamphlet 706-203 and was modified in a Technical Report by the US Army Agency for Aviation Safety. This scheme shows (in their Report 72-8) how the "process" works for aviation systems, but, its application to the total system safety endeavor was self-evident. Thus, the narrative has been organized to fit it into the process for any system. The remainder of this article discusses the individual blocks in some detail, but a little less formally than the Pamphlet. Basically, the process follows a classical safety pattern through which anything considered worth building proceeds. Although the individual blocks are shown in a logic sequence, this sequence is not sacrosanct, for one can enter the process at any point and any step can be repeated as required. It works for any level of development or procurement, from the simplist item to the most complex system. All you have to do is decide where you are when you begin and this depends on the end item and its life cycle. In this discussion, we assume that a requirement for an item has been validated and the early concept formulation and operational concept has been established.

BLOCK A - KNOWN PRECEDENT

When the developer peers over his crowded desk and has to decide how his project will unfold, the first thing he should think of is whether there is any past history of undesirable qualities in a similar item. If there is, then he will automatically know that the "new" item must avoid them, if it isn't to be the same headache to the user that he had to spend time correcting before. If there isn't, then he will have thoroughly screened the multiplicity of sources to find out. The logic of this step is to identify, collect, and use historical detail to avoid mistakes made before.

BLOCK B - SYSTEM DELINEATION

Once history is relegated to the bookshelf (but nevertheless remembered) the "new" system must be described in the most precise terms. One must know the environment in which it is expected to operate, its anticipated performance envelope, whether people are part of it or merely observers, what it will replace, and whether a significant improvement in operating characteristics will be realized. Each of these features is explained by the entity that generates the requirement and the safety man is expected to participate in each determination so that selection of some impossible parameter isn't an oversight that may prove embarrassing later.

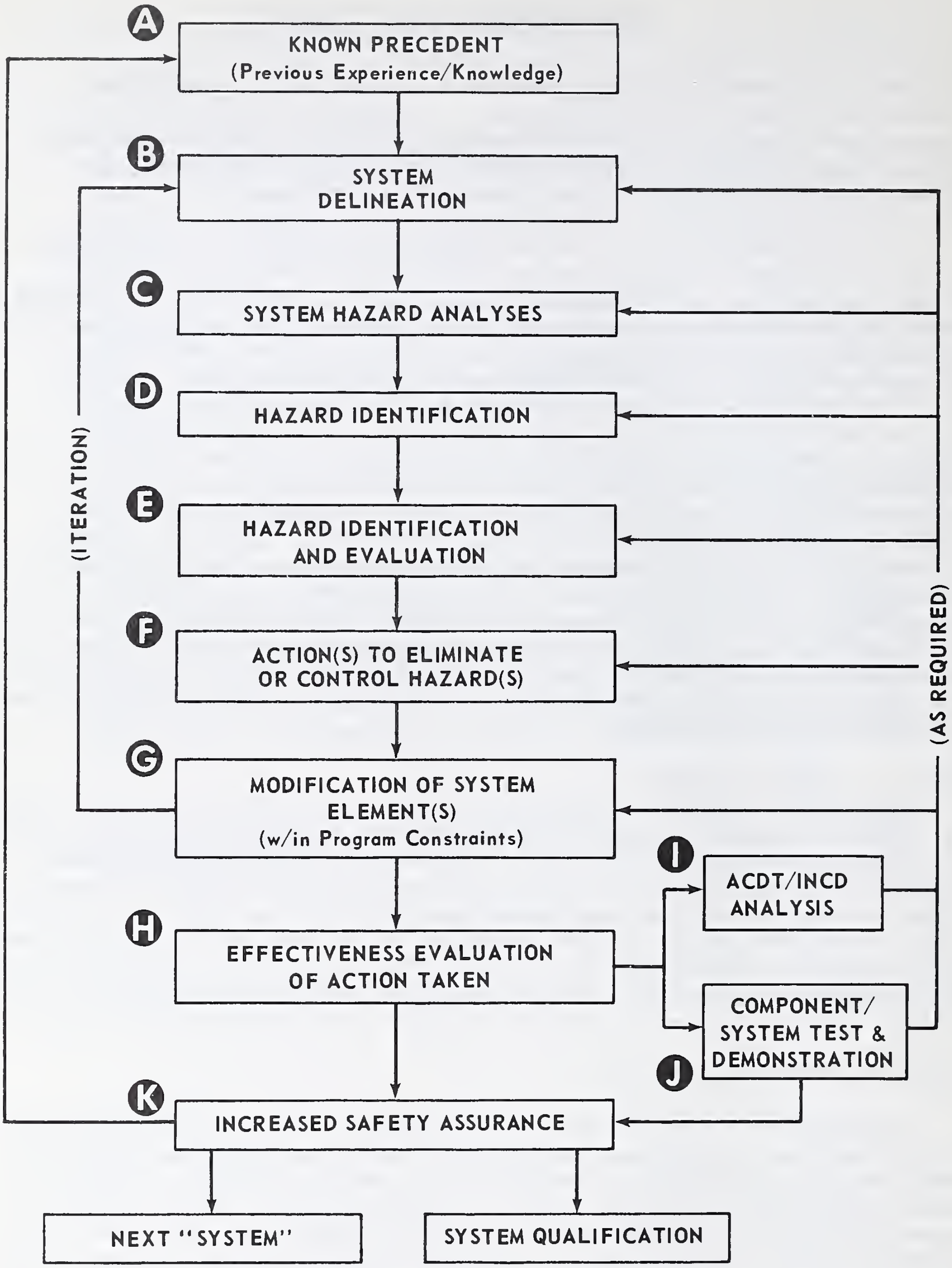


Figure 1
SYSTEM SAFETY PROCESS

BLOCK C - SYSTEM HAZARD ANALYSIS (SHA)

The basis for this rather all-inclusive title is to conceive of all the ways in which a system or process could cause difficulty. The primary question to be asked in this area is, "what if such-and-such happens?" Many of the answers will be nebulous initially, because definitive analyses have yet to be made. Likewise, many postulated situations will seem to surface from the art of bending over backwards to manufacture analytical work. In balance, it will be necessary to use mature, professional judgement to determine how elaborate the answer to any question need be. It is not necessary to answer the question, "what happens if a man contacts a 220 volt, 20 ampere electrical source?" It should, however, be mandatory that the possible condition that could bring him into contact with such a source be thoroughly analyzed and eliminated. Analysis of the system in a methodical manner, beginning with the Preliminary Hazard Analysis (PHA) of the design and continuing all the way through the SHA will insure that the job is done without becoming bogged down in hopeless detail. A number of techniques are available for these analyses, e.g., Failure Mode and Effect (FMEA), Fault Tree (FTA), and Technique for Human Error Prediction (THERP).

BLOCK D - HAZARD IDENTIFICATION

Once the hazard analyses disclose potential problems in the system, the specific hazards can be identified and marked for elimination or control. Blocks C and D more or less go hand-in-hand, since one is of little value without the other. In other words, hazards (except for an obvious one, as above) cannot be identified unless the system is analyzed. Likewise, analysis is of no value unless its purpose is to disclose potential hazards.

BLOCK E - HAZARD CATEGORIZATION AND EVALUATION

It is not possible to be absolutely sure that any hazard can be eliminated and attempts to eliminate all hazards will be impractical. Thus, categorization of hazard levels according to MIL-STD-882 in terms of severity (ranging from no danger at all to complete destruction of a system) is required. We often design the human out of a portion of a system, but we will never be able to eliminate his potential for making mistakes in that part where he still performs. The analytical techniques mentioned earlier are put to good use within the hazard classification description in the Standard. The criteria which has been found excellent for this kind of categorization can be summarized as follows:

1. In looking at any particular potential hazard, determine the "worst-case" if it were not eliminated or controlled.

2. Evaluate the effect that hazard would have on the mission of the system; whether people would suffer injury, how much damage would be done to equipment, and the ultimate effect the event would have on the total system acquisition and operational program.

If we take these two prime criterion and amplify them a little we can immediately see that the major hazard causes are personnel error, environmental conditions, poor design, improper procedures, and the ancient headache - it just comes apart for no apparent reason, or doesn't function as it should.

Going to the next step, the effects of all these unusual events can be ranked according to levels or degrees of severity and the probabilities of occurance under all operating conditions determined. Once this is done, the cost of correcting the situation can be readily established. Here is where trade-off's will occur in terms of dollars, actual benefits gained, schedules, and system performance. Summarizing the categorization, MIL-STD-882 ranks hazards in this manner:

1. Negligible - you have no problems here.

2. Marginal - you had better look closer; change a procedure, construct a warning sign, or enhance operator training.

3. Critical - now you have a major problem; someone hasn't done his homework, but you still can bail yourself out with strenuous effort.

4. Catastrophic - call the mortician or the salvage officer.

BLOCK F - ACTION(S) TO ELIMINATE OR CONTROL HAZARD(S)

Although all the above reads well and is good philosophy, nothing done thus far will prevent the first mishap. Management is responsible for this step, based on recommendations made in the preceding safety analyses and studies. Undoubtedly, this is the most crucial step, because it is only here that practical results can be achieved. Authority must be granted to redesign, change procedures, and do those things which inspire confidence in the operator when he uses the equipment.

BLOCK G - MODIFICATION OF SYSTEM ELEMENTS

As an outgrowth of the previous step, the actual modification of some element or elements of the system takes place. For example, procedures can be revised, initial assumptions on the operating environment can be amended, or basic specifications can be changed. Since this changes the system, its initial definition and some elements also change; therefore, the description (Block B) must be revised. The process is repeated until no unacceptable hazards are generated. This repetition ensures that actions taken to correct one hazard do not induce others somewhere else.

BLOCK H - EFFECTIVENESS EVALUATION OF ACTION TAKEN

If all we've done thus far could assure us that we were 100% correct the "process" would end. The measuring tool is the test. The test, whether it is engineering, development, or operational proves whether the modification, change, or whatnot has actually improved the system when

compared to the established objective. Blocks I and J are an extension of this step. We thereby increase our assurance in the safety level of the system (Block K) by "iterating" through this one.

BLOCK I - ACCIDENT/INCIDENT ANALYSIS

The first sub-step of Block H is an obvious fact of life, i.e., any accident which causes death or major destruction must be thoroughly investigated. Finding the true cause is the most difficult; and in particular if a "near miss" is evident an investigator has a real problem. The "near miss" is where a situation, if continued to its logical conclusion would have resulted in the same catastrophic or critical condition. It is difficult, because human nature regards an end result as more important than the underlying cause, particularily if the event did not result in an undesirable situation when it happened. This may occur once, twice, or any number of times, but eventually time will run out.

Each event must be investigated as soon as possible after occurrence, otherwise a delay may permit removal or destruction of significant evidence. Retention of damaged equipment for post mortem examination is mandatory, otherwise the investigation may be only an exercise in documentation research. Once the investigation is underway, there are several criterion the investigator must remember:

1. Find the exact cause(s) so it can be avoided later.

2. Use system safety analysis techniques to determine the "change" or "deviation" that produced the event.

3. Recommend changes in procedures or hardware to prevent repetition of the same event.

4. Feed-back the data to support product improvements or modifications.

5. Publicize the technical detail so that users of the same equipment can avoid identical errors.

6. Record the data for future reference, so that one does not have to reinvent the wheel again.

BLOCK J - COMPONENT/SYSTEM TEST AND DEMONSTRATION

This is the second sub-step of Block H and along with Block I results in an increased assurance that the system will indeed meet its new criteria. The tests and demonstrations verify the results of the "process" and give confidence in the assurances. Hand-in-hand with accident/incident analysis, deficiencies and shortcomings in this step are directed to other appropriate steps in the process for corrective action.

BLOCK K - INCREASED SAFETY ASSURANCE

Where the effectiveness evaluation (Block H) indicates that the process has produced the desired results, assurance that the objective has been met is also increased. The next time we go through this process, as an element of system qualification, or in applying the process to the "next" or "another" system, we continually build on past successes, while simultaneously correcting deficiencies.

* * * * *

The System Safety Process described here might seem unusually complicated, but if the individual segments are scrutinized carefully it can be readily seen that each is done over and over again in the routine management of our safety programs. To the staffer who faces a mountain of paper every morning, these formal steps may seem remote and far away. It is well, though, to occasionally look at the total scheme and perhaps that little piece of the action with a suspense tomorrow morning may seem more important after all. Likewise, to the technician operating the machine that produces an obscure piece of a system, his routine may not seem quite so insignificant if he can recognize that he, too, contributes to the success of the whole. Finally, to the operator and those who direct his activities, the "candid" disclosure of errors and hardware problems will help immeasurably the engineer who often has to <u>guess</u> why a particular anomaly occurred.

TOBYHANNA "ZERO IN ON SAFETY" DISPLAY

READ

HEED

THE

NEW

SIGNS